Tradestudy for Platforming strategy and Product Line Engineering

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Session: V3.1.3: Aerospace | Presentation#388

Introductions

BLUE KEI
S O L U T I O N S

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Outline

- ❑ Background of PLE

- ❑ Perspectives (inwards vs customer facing)

- ❑ Challenge
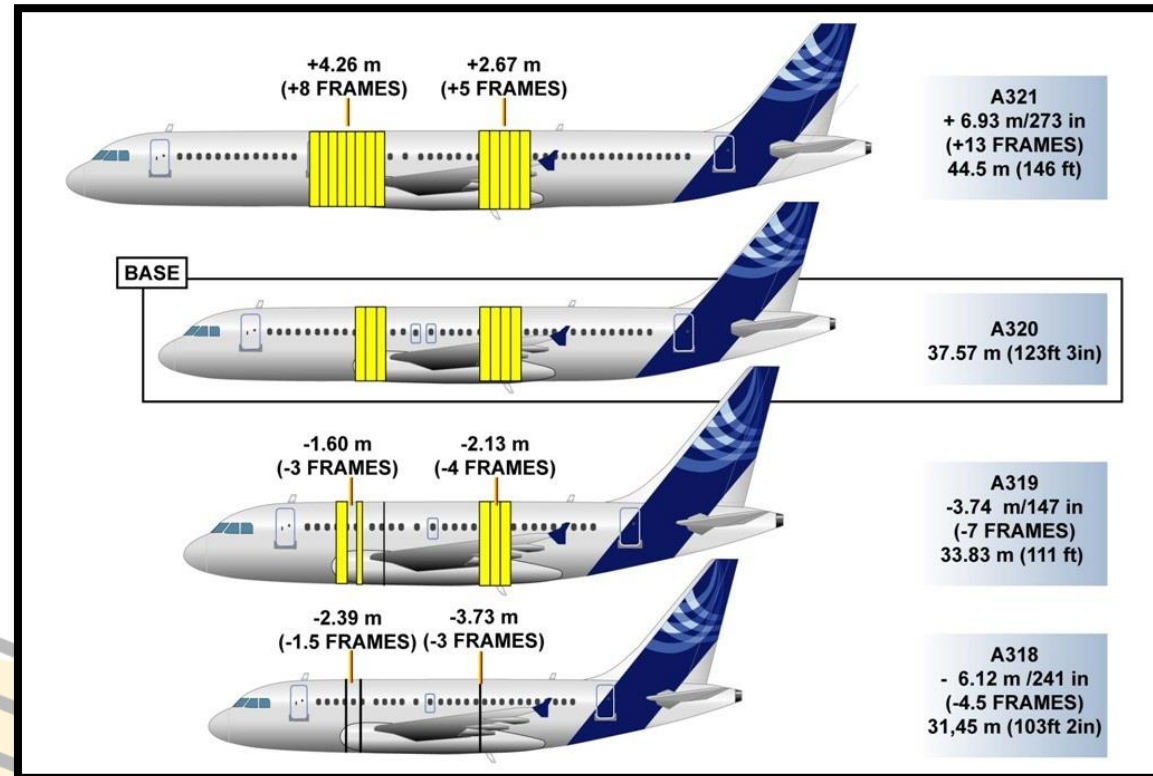
- ❑ Framework

- ❑ Learnings
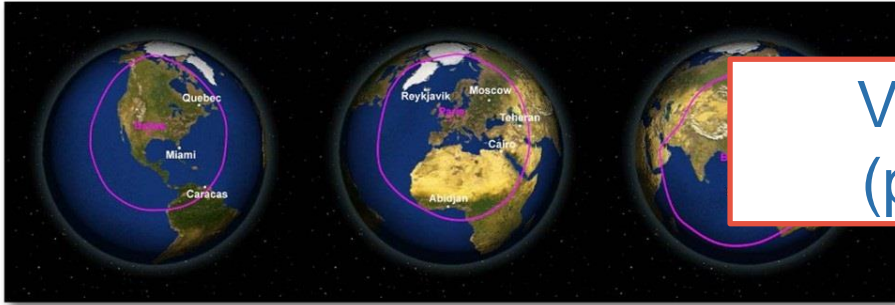
PLE

Background & Landscape

What is PLE?

Product Line Engineering (PLE) is a strategic approach to *developing a family of related products*, leveraging their commonalities while managing their differences to improve efficiency, reduce costs, and enhance quality.

A320 Example

+4.26 m (+8 FRAMES) +2.67 m (+5 FRAMES)

A321 + 6.93 m/273 in (+13 FRAMES) 44.5 m (146 ft)

BASE

A320 37.57 m (123ft 3in)

-1.60 m (-3 FRAMES) -2.13 m (-4 FRAMES)

A319 -3.74 m/147 in (-7 FRAMES) 33.83 m (111 ft)

-2.39 m (-1.5 FRAMES) -3.73 m (-3 FRAMES)

A318 - 6.12 m /241 in (-4.5 FRAMES) 31,45 m (103ft 2in)

Variability in Design (solution domain)

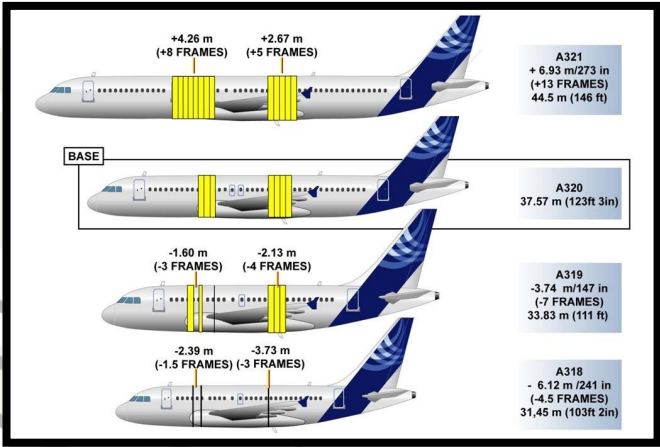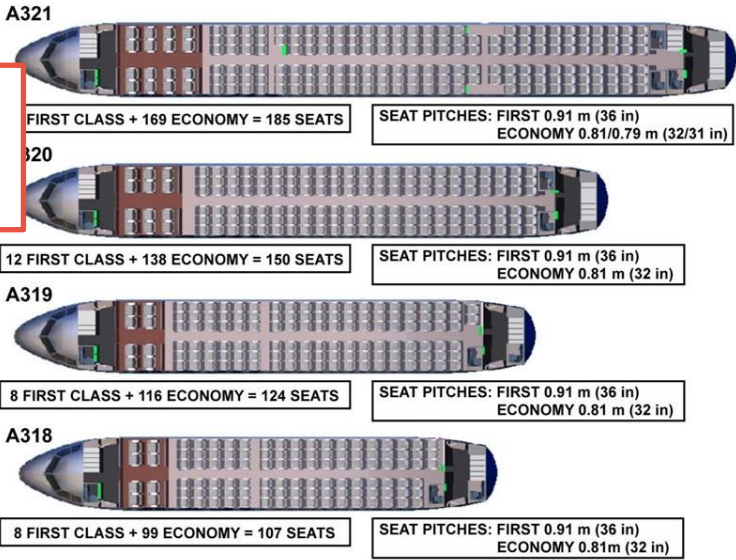https://training.egyptair.com/Maintenance/A320Family

Variability in Need
(problem domain)

WITH AN MTOW OF 77 tons (170 000 lbs), THE A320 HAS A RANGE OF 3600 Nm AS SHOWN ABOVE.
- FOR THE A318, WITH AN MTOW OF 66 tons (145 500 lbs), IT IS 3900 Nm.
- FOR THE A319, WITH AN MTOW OF 68 tons (150 000 lbs), IT IS 4200 Nm.
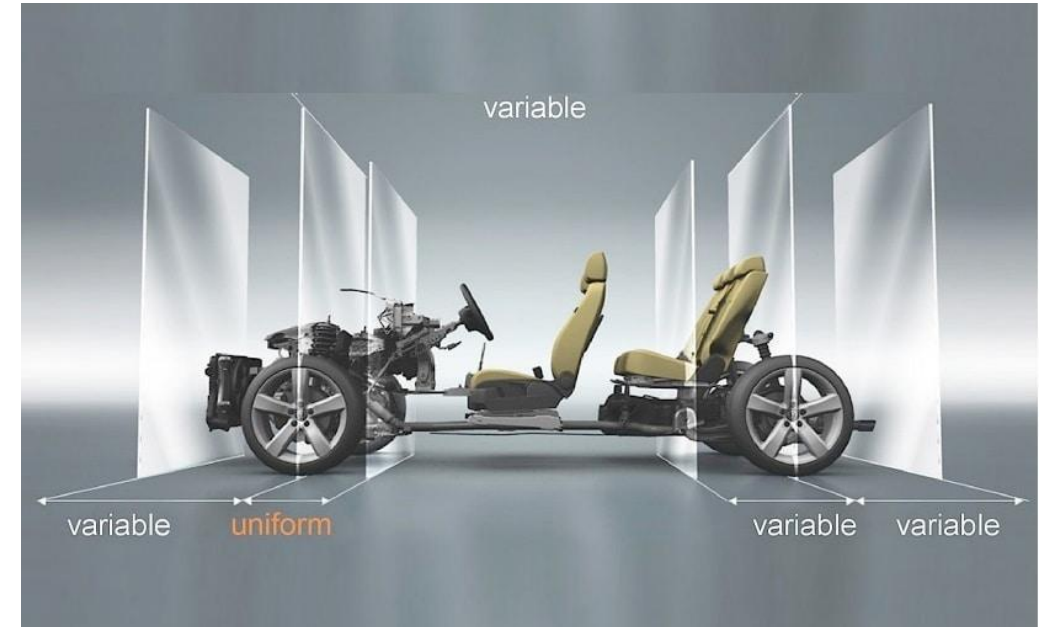- FOR THE A321, WITH AN MTOW OF 83 tons (183 000 lbs), IT IS 3100 Nm.
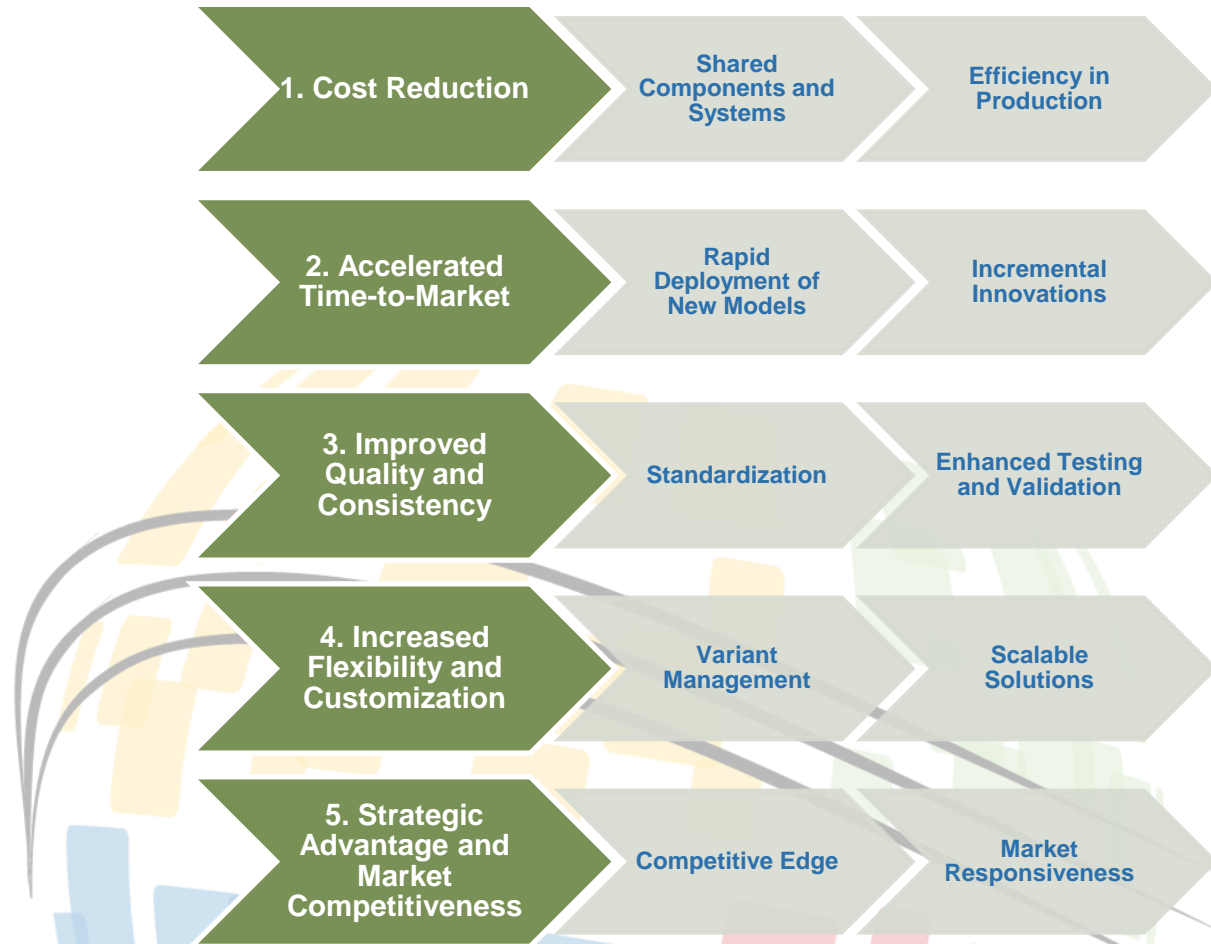
MTOW: Maximum Take-Off Weight

A321
FIRST CLASS + 169 ECONOMY = 185 SEATS | SEAT PITCHES: FIRST 0.91 m (36 in) ECONOMY 0.81/0.79 m (32/31 in)

A320
12 FIRST CLASS + 138 ECONOMY = 150 SEATS | SEAT PITCHES: FIRST 0.91 m (36 in) ECONOMY 0.81 m (32 in)

A319
8 FIRST CLASS + 116 ECONOMY = 124 SEATS | SEAT PITCHES: FIRST 0.91 m (36 in) ECONOMY 0.81 m (32 in)

A318
8 FIRST CLASS + 99 ECONOMY = 107 SEATS | SEAT PITCHES: FIRST 0.91 m (36 in) ECONOMY 0.81m (32 in)

Variability in Design
(solution domain)

https://training.egyptair.com/Maintenance/A320Family

Industry Examples

VW MLB Platform

Why Platform Engineering?

1. Cost Reduction → Shared Components and Systems → Efficiency in Production

2. Accelerated Time-to-Market → Rapid Deployment of New Models → Incremental Innovations

3. Improved Quality and Consistency → Standardization → Enhanced Testing and Validation

4. Increased Flexibility and Customization → Variant Management → Scalable Solutions

5. Strategic Advantage and Market Competitiveness → Competitive Edge → Market Responsiveness

Tesla's Major Recall Shows the Benefits of Software-Defined Vehicles

James Falkiner *Dec 19, 2023*

Tesla's recent recall could have cost it billions of dollars, but instead, an over-the-air software update was all that was required to fix an issue affecting over 2 million vehicles.

Traditionally, a mass recall would require every vehicle to be returned to a repair shop to be fixed at a significant cost to the automaker. Even a software issue, such as a safety issue with a battery management system, can require a recall.
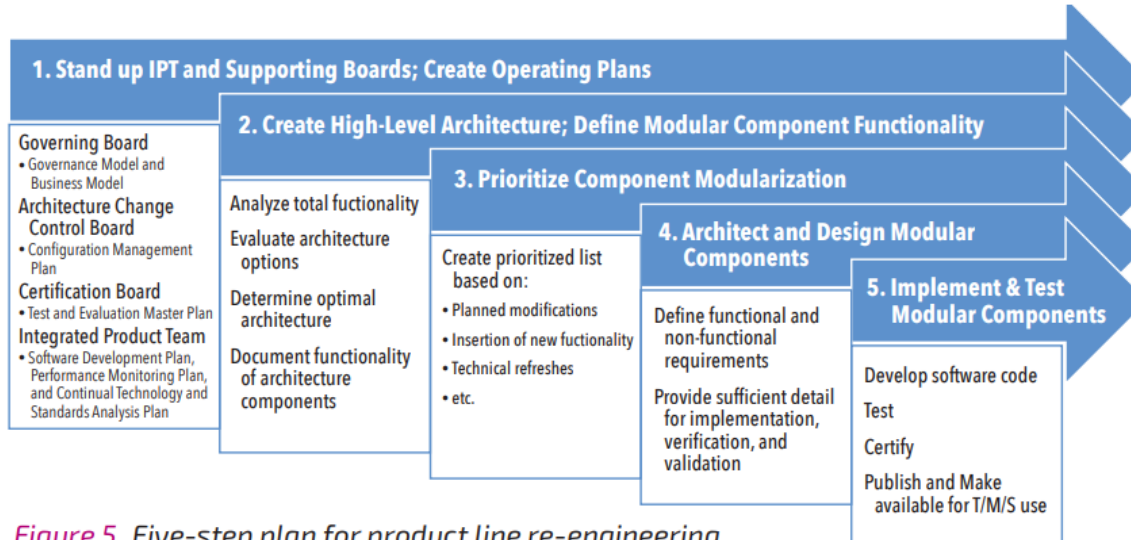
Background Research

Feature-based Systems and Software Product Line Engineering: A Primer

INCOSE

Feature-based Product Line Engineering lets you build your product line portfolio as a single production system rather than a multitude of individual products.

INSIGHT

This Issue's Feature:
Product Line Engineering in Context

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A PUBLICATION OF THE INTERNATIONAL COUNCIL ON SYSTEMS ENGINEERING

INCOSE

Background Work

Figure 5. Five-step plan for product line re-engineering

Product Line Re-Engineering for Modularity in a US Department of Defense Project
John Wood and Glenn Tolentino
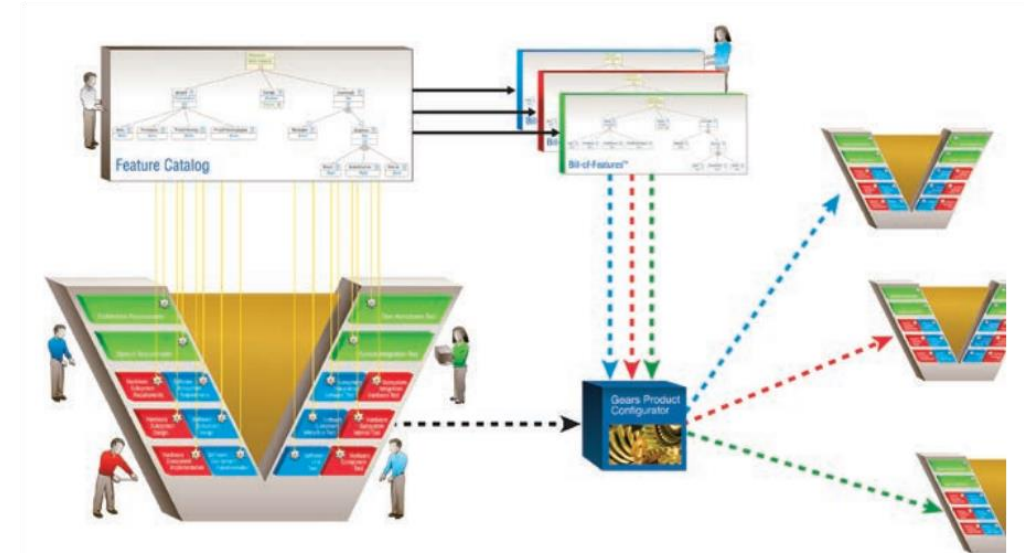
Figure 1. The Feature-Based PLE factory configuring PLE shared asset supersets into product-specific instances according to a product's bill-of-features

Big Lever
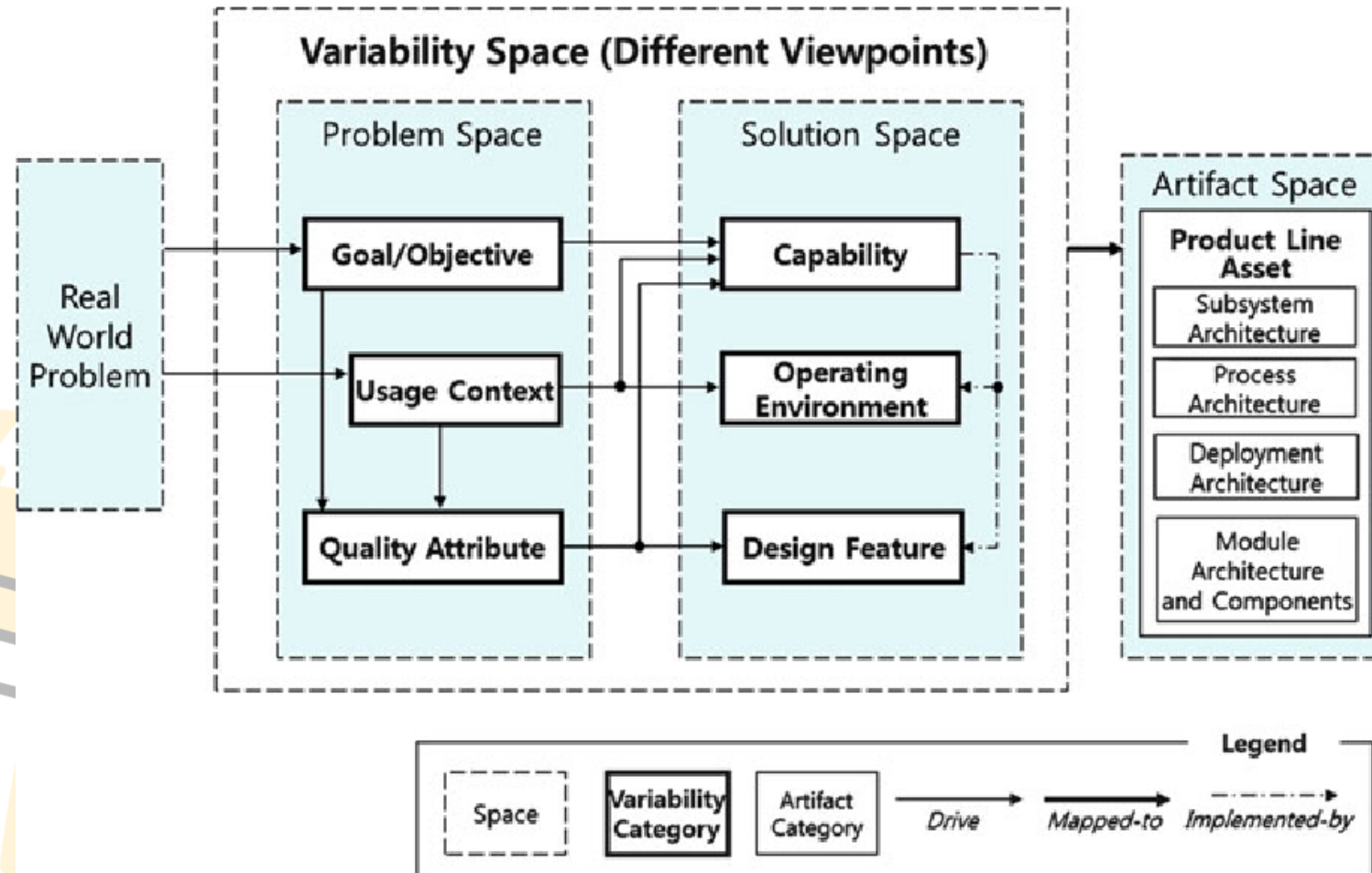
Challenges, Strategy & Tactics
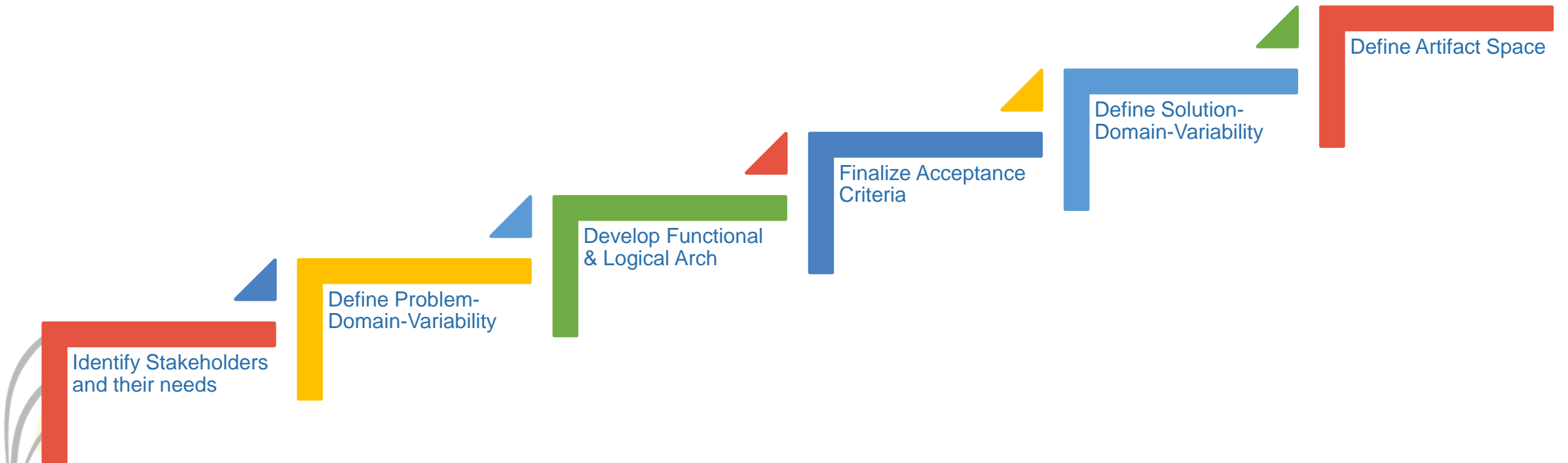
PLE
Challenges

Defining
Variability &
Commonality

Managing
Variability &
Commonality

Variability Space

Kang, Kyo Chul. "Chapter 2 Variability Modeling." (2017).

Framework for identifying Variability

Define Artifact Space

Define Solution-Domain-Variability

Finalize Acceptance Criteria

Develop Functional & Logical Arch

Define Problem-Domain-Variability

Identify Stakeholders and their needs

Case Study – Problem Definition

To produce the right set of Variants to offer in the market, which would optimise engineering, manufacturing, supply management, installation and usage effectively.
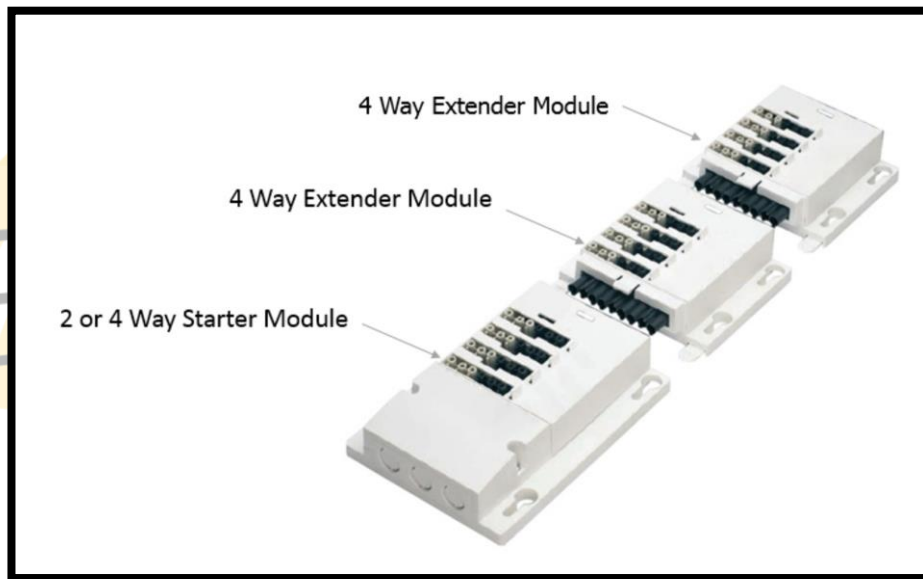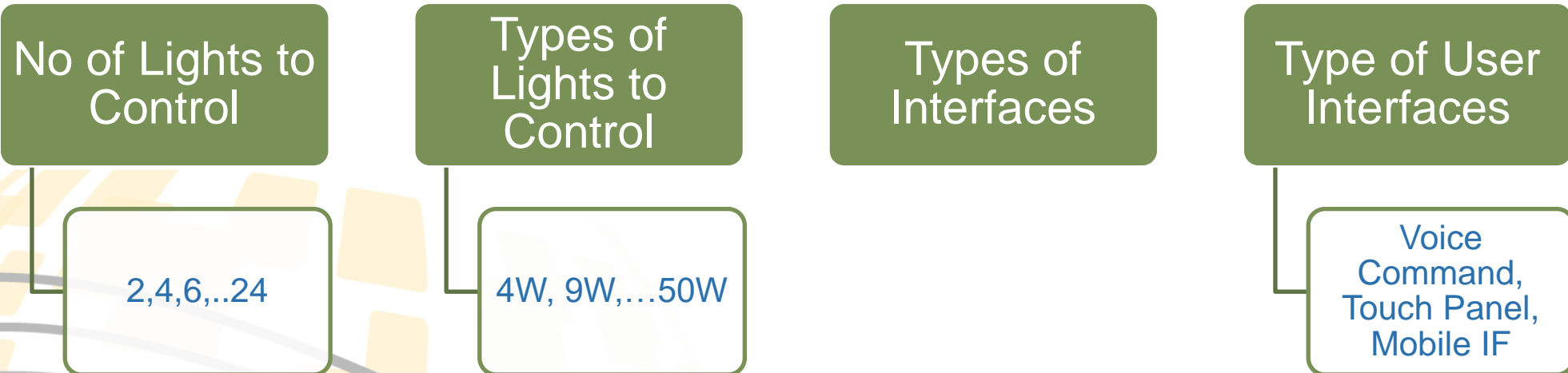

Note : These images are indicative, as we cannot share images of real product due to proprietary nature of the project
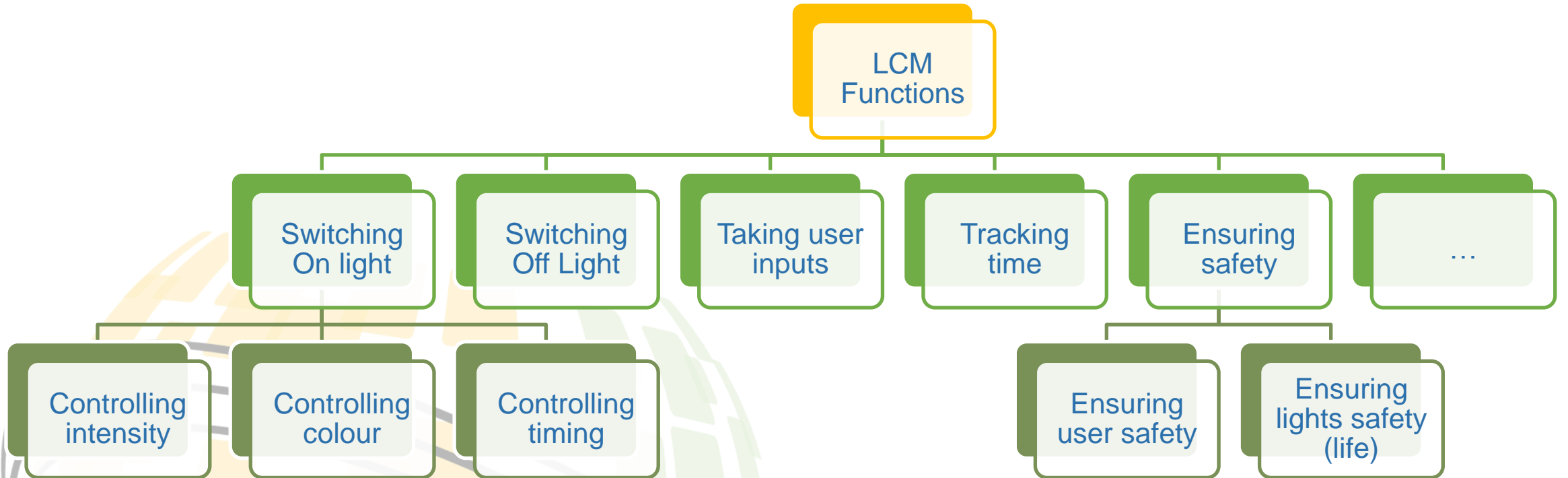
Stakeholder Analysis
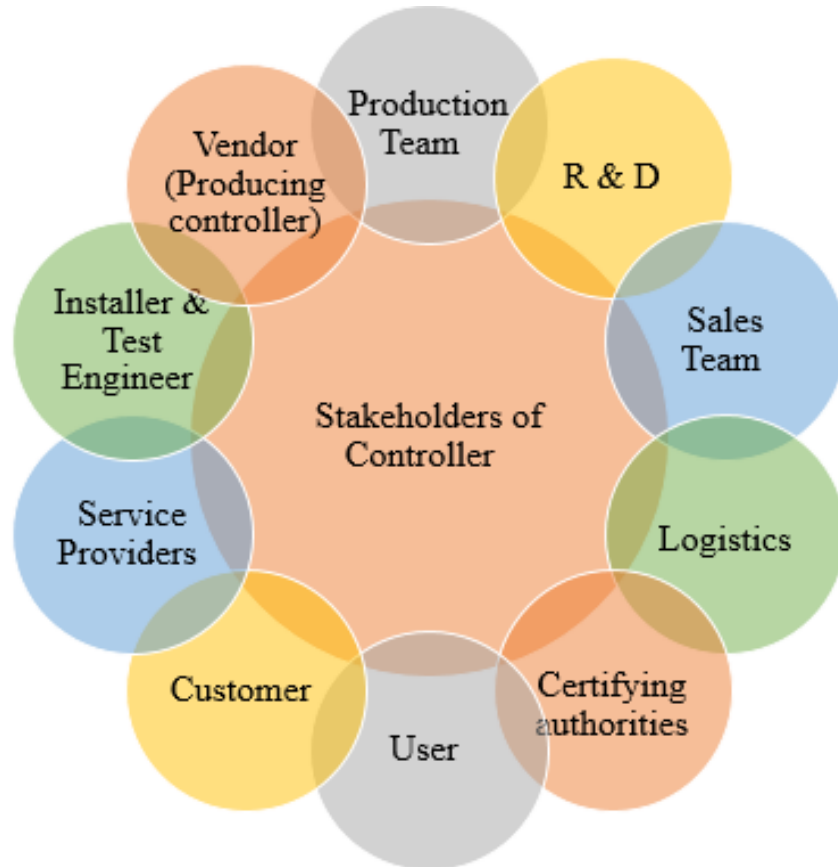
- ✓ Reduce the number of iterations required during product development life cycles

- ✓ Increase operational efficiency, reduce costs, and increase revenue from the company's end

- ✓ Analyze the variabilities based on the ratings and dependencies
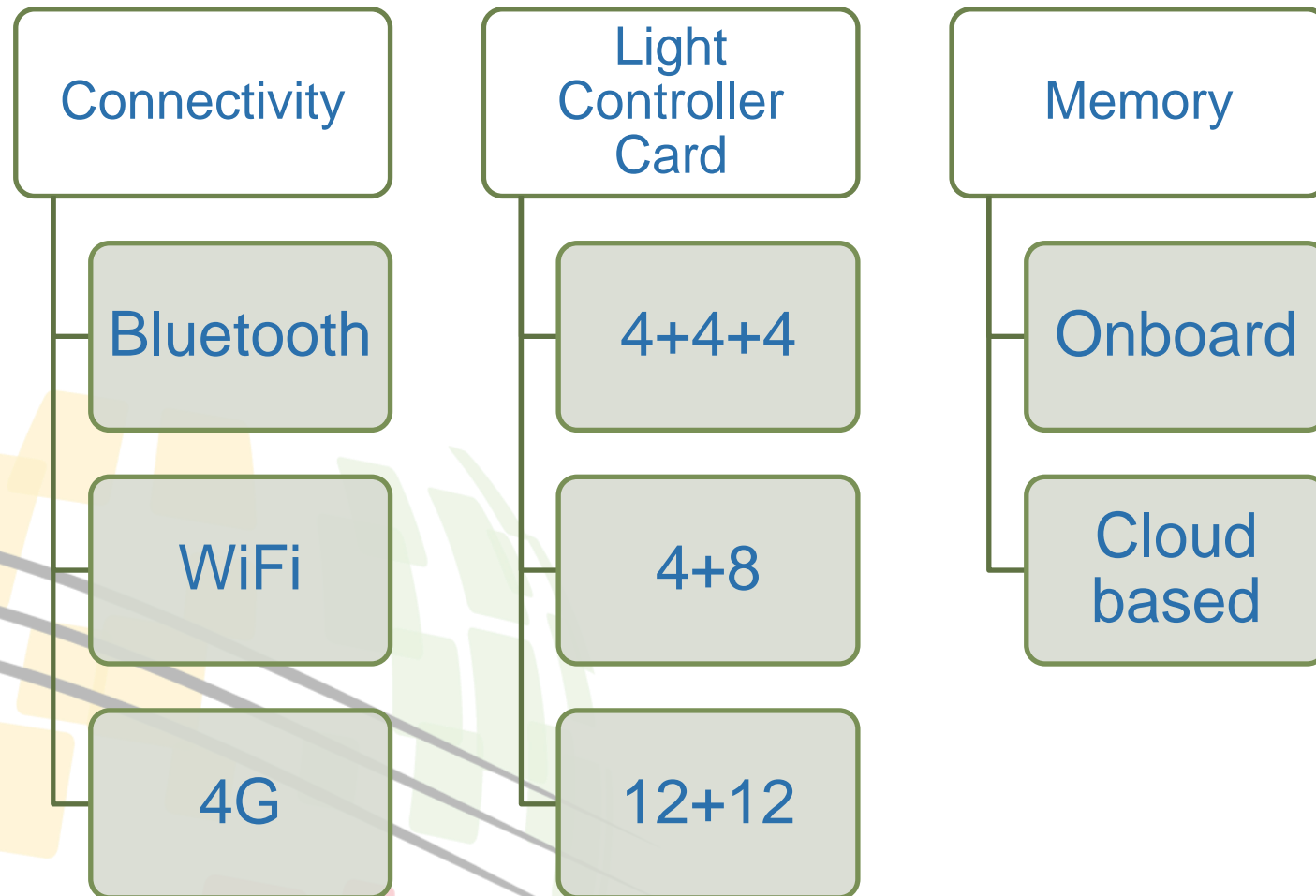
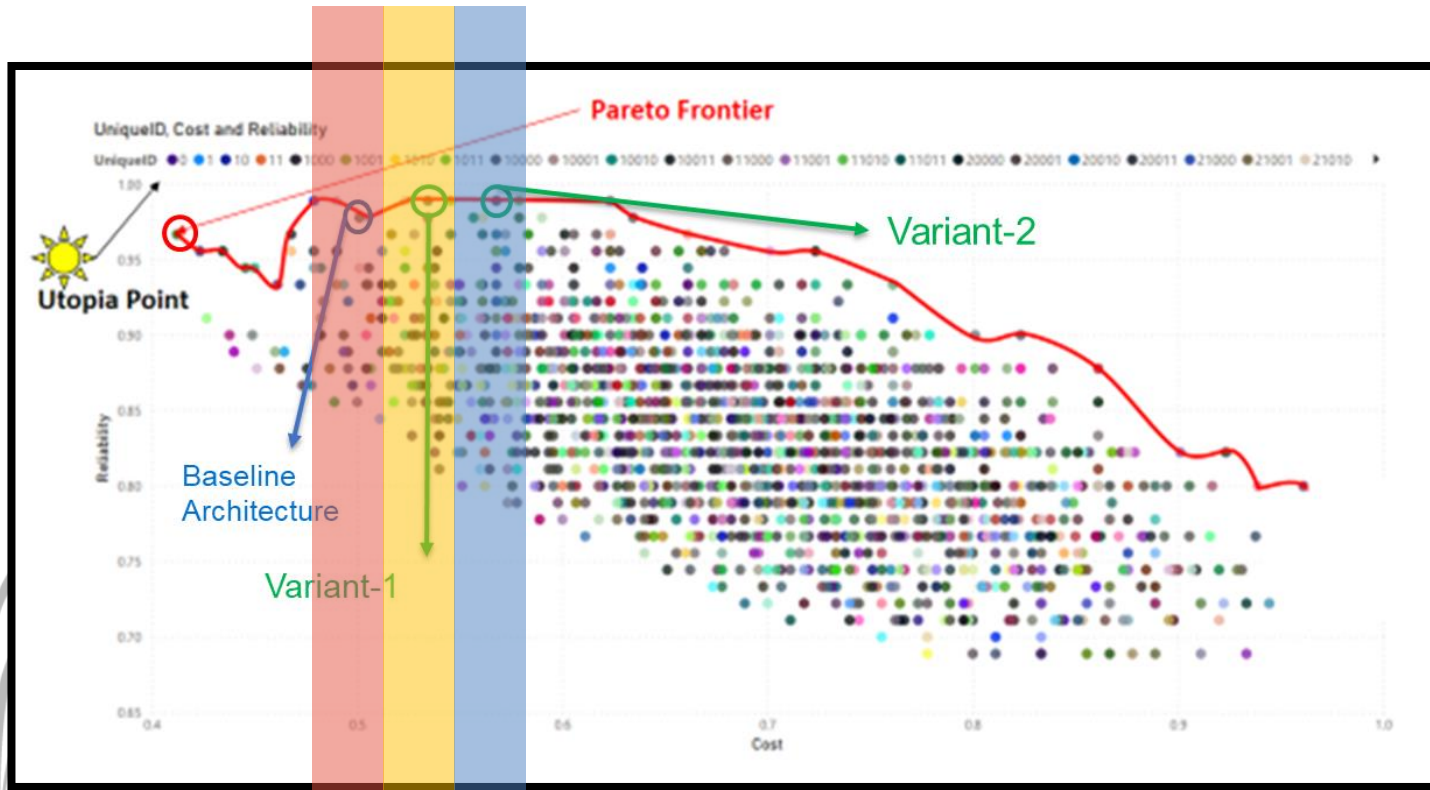- ✓ Shortlist the best possible variants

Variability in Problem Domain

No of Lights to Control	Types of Lights to Control	Types of Interfaces	Type of User Interfaces

No of Lights to Control → 2,4,6,..24

Types of Lights to Control → 4W, 9W,…50W

Type of User Interfaces → Voice Command, Touch Panel, Mobile IF

Functional Architecture & exploring Design Choices

Variability in Solution Domain

Connectivity	Light Controller Card	Memory
Bluetooth	4+4+4	Onboard
WiFi	4+8	Cloud based
4G	12+12	

Tradestudy wrt Acceptance criterias

Illities

Performance	Product Cost
Complexity	Modularity
Maintainability	Serviceability
Usability	Robustness

Tradestudy wrt Acceptance criterias
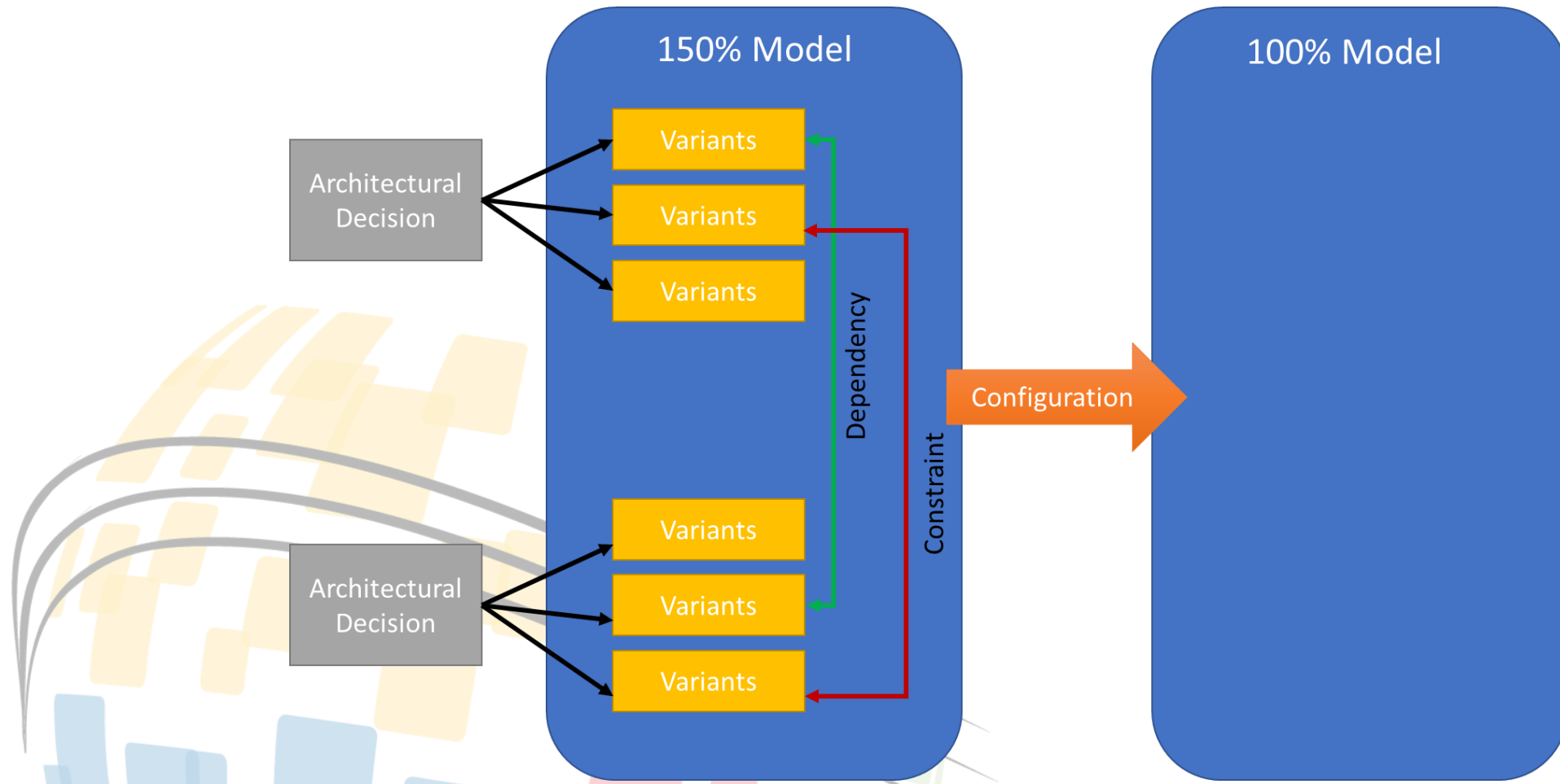

Segments
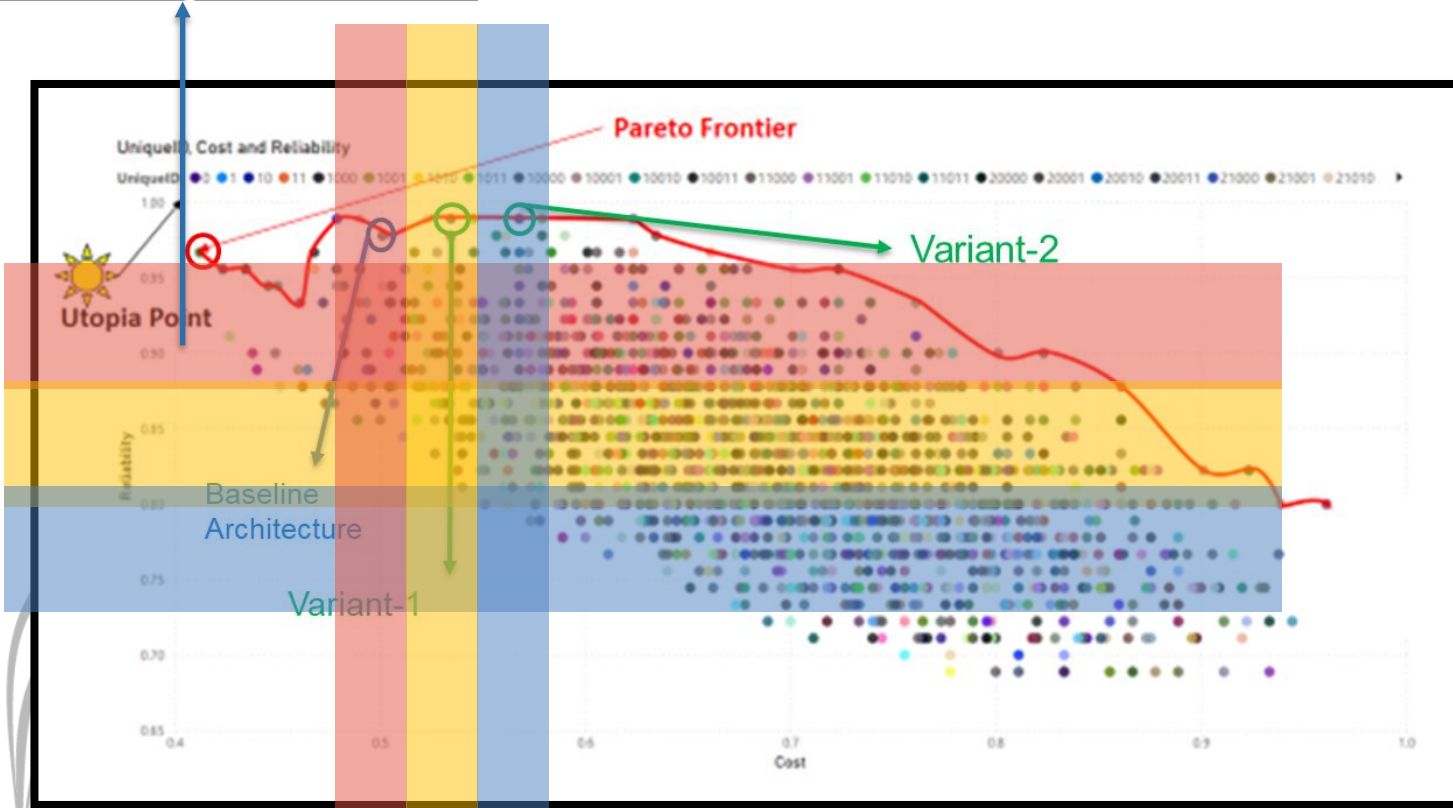
User Centric Features

Comfort	Ability to track history
Control Colours	Control Intensity

...

Final Stage – Setting up PLE

Defining Artifact Space

Var 1

| Wifi + BLE + 4G |
| Cloud Connectivity |
| 16 Lights |
| On Chip ROM |

Var 2

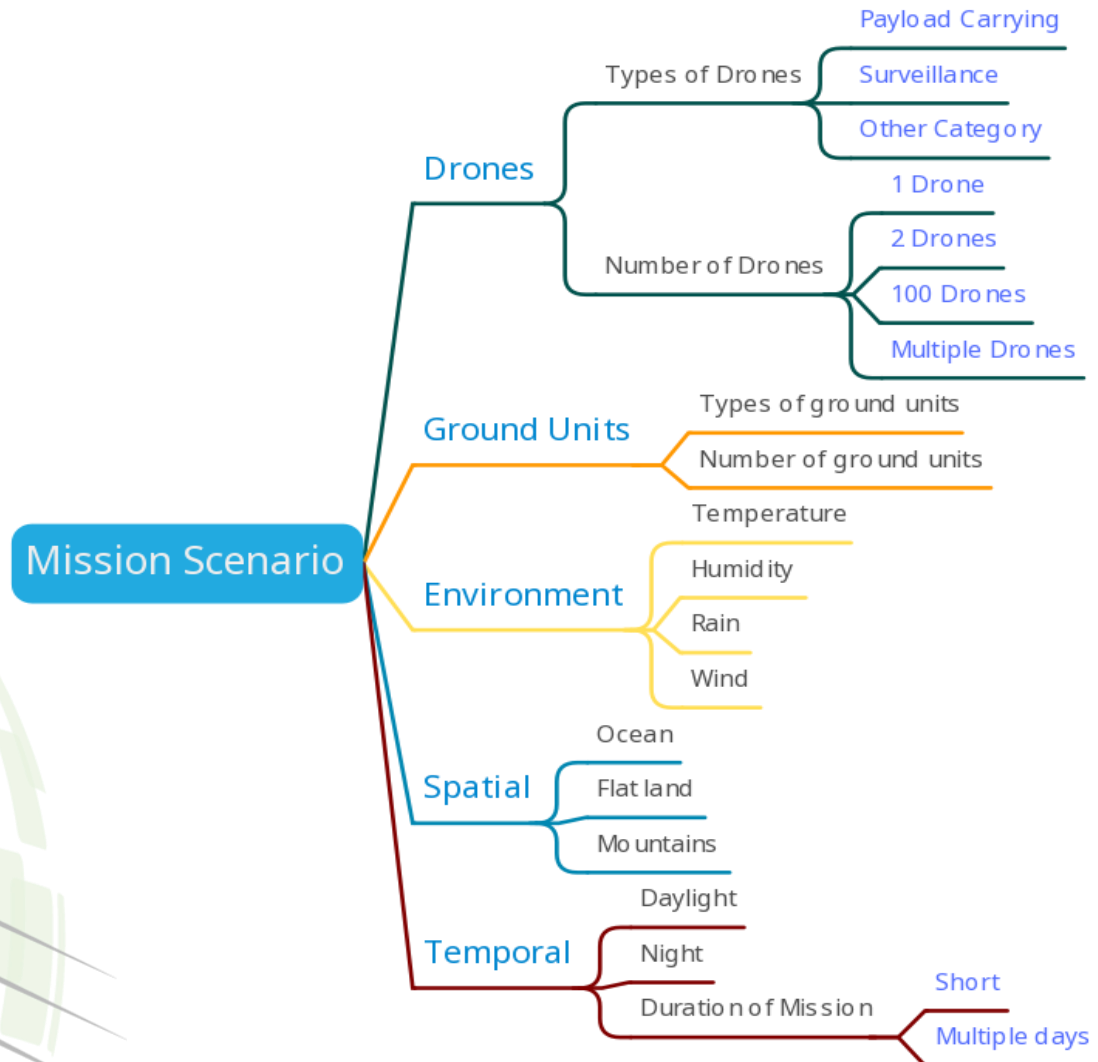| Wifi + BLE |
| 16 Lights |
| Cloud Connectivity |
| On Chip ROM |

Var 3

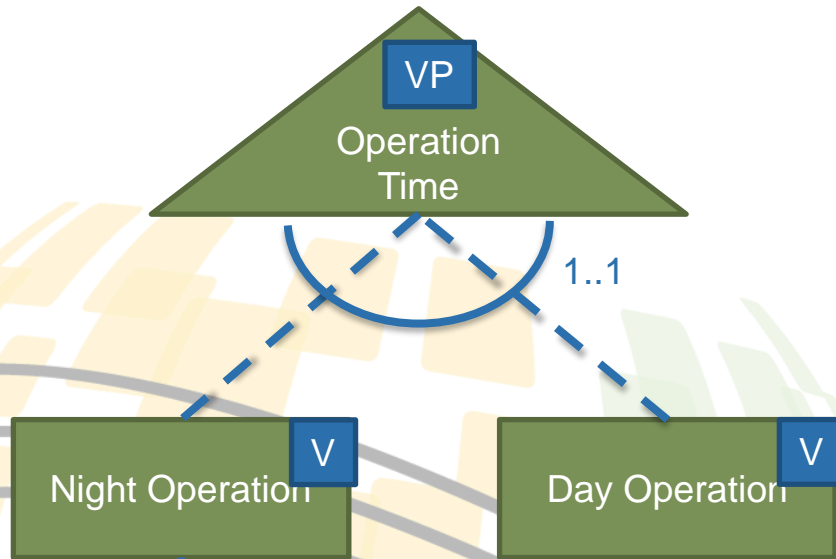| Wifi |
| 16 Lights |
| Cloud Connectivity |

Traceability across variability
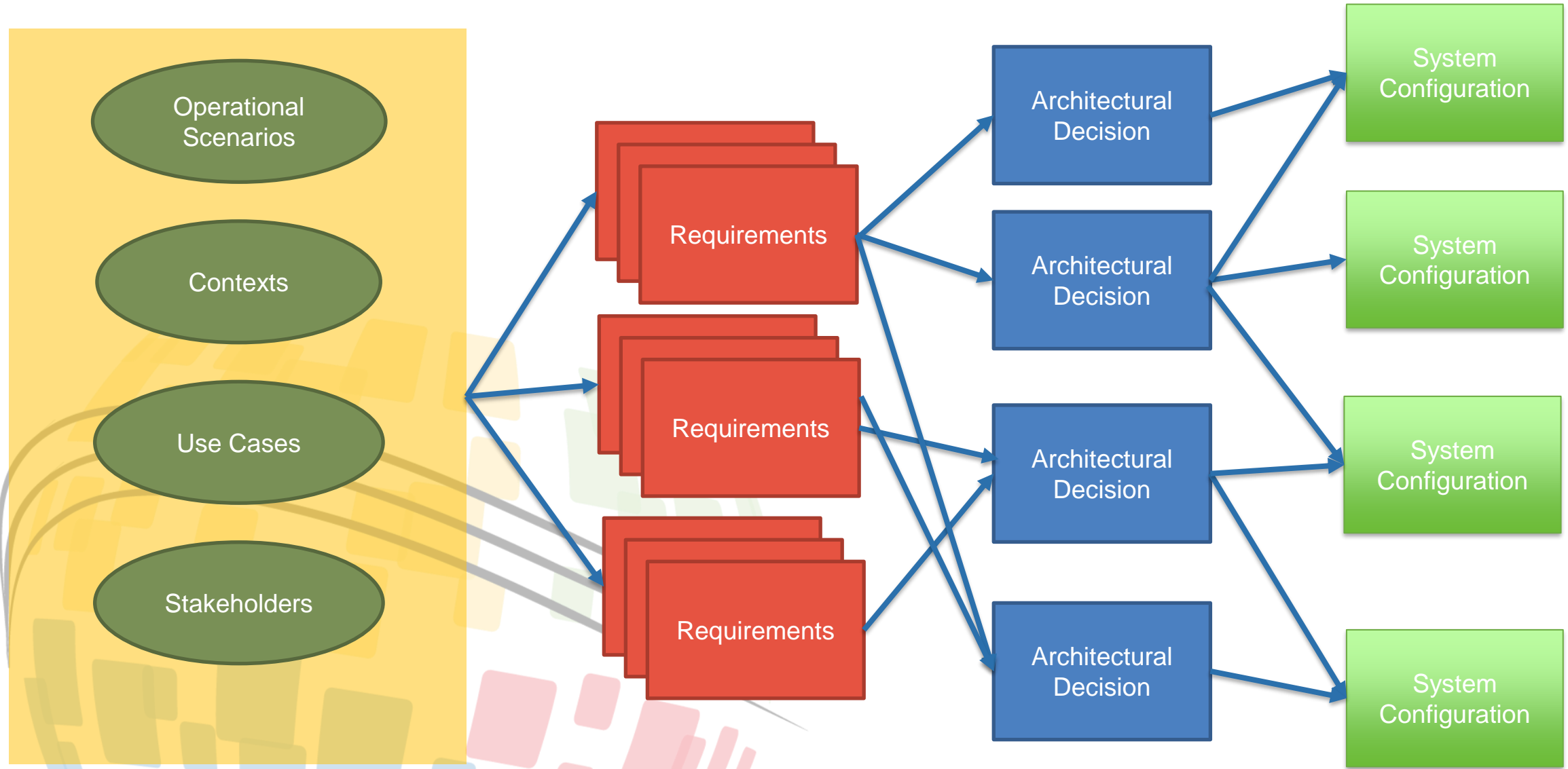
Extending the Framework in Mission Scenario Planning

A single mission scenario could

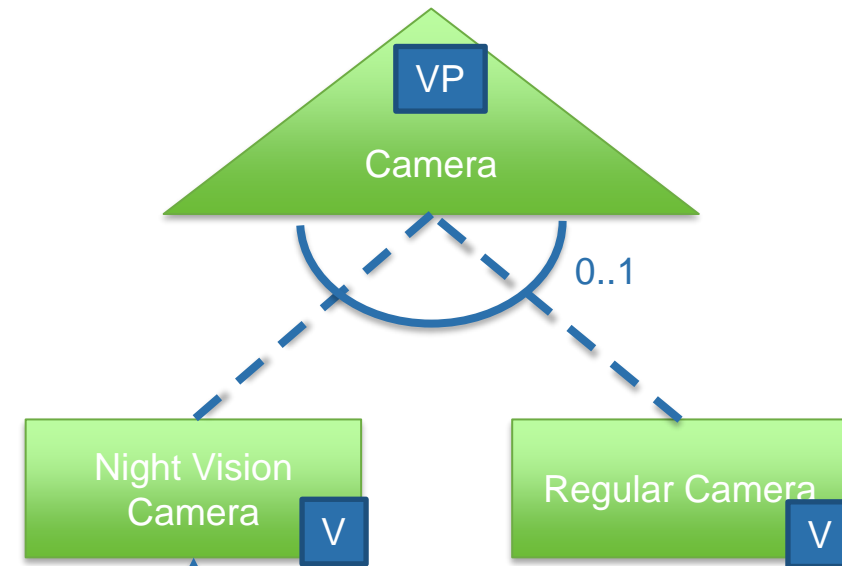**have multiple solutions, and is**

dependent on multiple variables

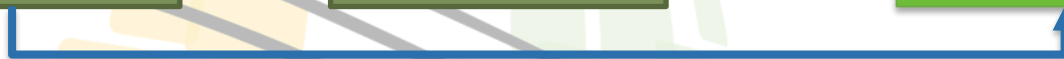# Moving from Problem Domain → Solution Domain

Moving from Problem Domain → Solution Domain

Operational Variability

VP — Flight Duration

1..2

V — 30 min

V — 45 min

Solution Variability

VP — Battery Capacity

1..3

V — 5000 mAh

V — 8000 mAh

V — 1000 mAh

Excludes
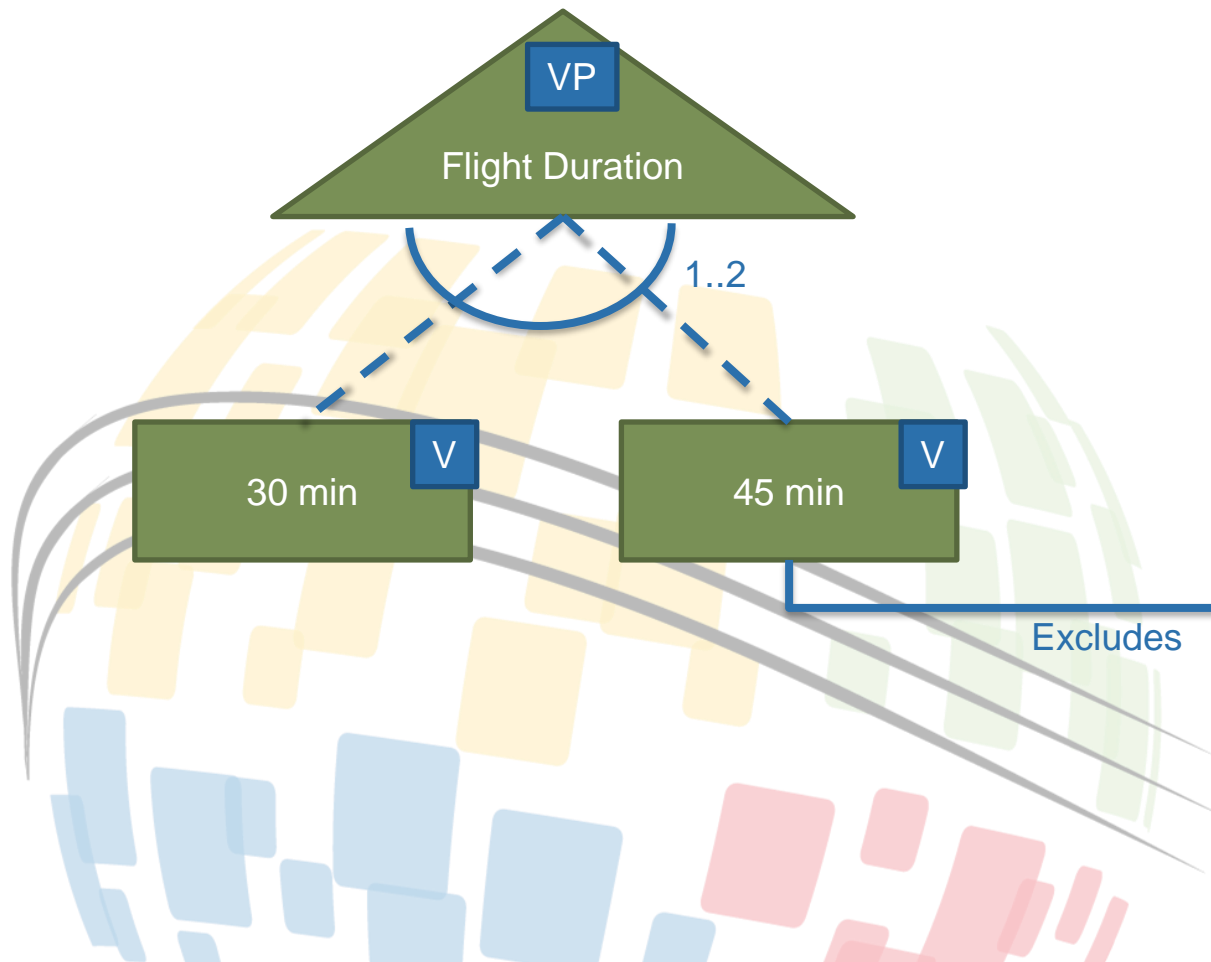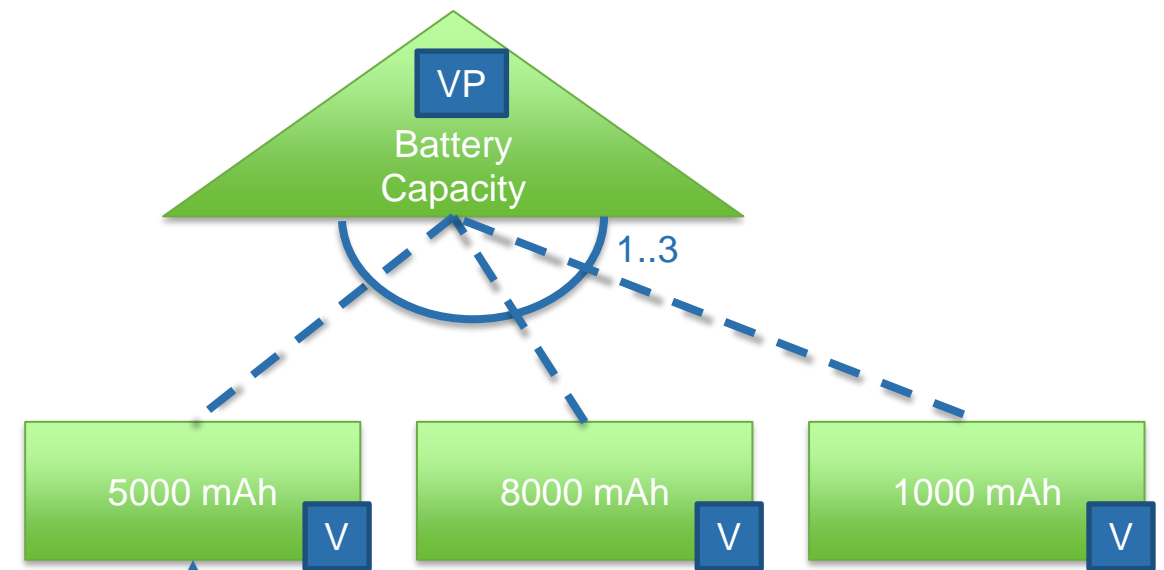
Learnings

✓ Always start with stakeholder interviews

✓ Interview them jointly, but also separately. You might be surprised the difference these settings make.

✓ Tradespace analysis came out to be a very powerful tool to systematically analyse design choices

✓ Traceability helped in keeping of all 150% Needs down till Design

✓ Excel/VBA + PowerBI / Python came out as low cost solution for one time activity, however change management was not easy

✓ Base line architecture always helps.

Questions?

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Stueti Gupta
Digital Engineering using MBSE ~ I think Systems ~ STEM advocate

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www.incose.org/symp2024
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